PB-239 572

# SHAWANO LAKE, SHAWANO COUNTY, WISCONSIN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Wisconsin National Guard
Wisconsin Department of Natural Resources

October 1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

TECHNICAL REPORT DATA
*(Please read Instructions on the reverse before completing)*

| 1. REPORT NO. | 2. | PB 239 572 |
|---|---|---|

**4. TITLE AND SUBTITLE**
Report on Shawano Lake, Shawano County, Wisconsin

**5. REPORT DATE**
Prepared October 1974

**6. PERFORMING ORGANIZATION CODE**

**7. AUTHOR(S)**
Anonymous (National Eutrophication Survey Staff)

**8. PERFORMING ORGANIZATION REPORT NO.**
Working Paper # 48

**9. PERFORMING ORGANIZATION NAME AND ADDRESS**
Pacific Northwest Environmental Research Laboratory
U.S.Environmental Protection Agency
200 S. W. 35th St.
Corvallis, Oregon 97330

**10. PROGRAM ELEMENT NO.**
1BA029

**11. CONTRACT/GRANT NO.**

**12. SPONSORING AGENCY NAME AND ADDRESS**
U.S. Environmental Protection Agency

**13. TYPE OF REPORT AND PERIOD COVERED**
Final - 1972

**14. SPONSORING AGENCY CODE**

**15. SUPPLEMENTARY NOTES**
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

**16. ABSTRACT**
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

**17. KEY WORDS AND DOCUMENT ANALYSIS**

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| eutrophication<br>lakes<br>nutrients<br>phosphorus<br>nitrogen<br>loading | | 05B<br>05C |

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

PRICES SUBJECT TO CHANGE

| 18. DISTRIBUTION STATEMENT | 19. SECURITY CLASS *(This Report)* | 21. NO. OF PAGES |
|---|---|---|
| Release unlimited | | 35 |
| | 20. SECURITY CLASS *(This page)* | 22. PRICE |
| | | 3.75/2.25 |

CONTENTS


| | Page |
|---|---|
| Foreword | ii |
| List of Wisconsin Study Lakes | iv, v |
| Lake and Drainage Area Map | vi |
| **Sections** | |
| I. Conclusions | 1 |
| II. Introduction | 3 |
| III. Lake and Drainage Basin Characteristics | 4 |
| IV. Lake Water Quality Summary | 5 |
| V. Nutrient Loadings | 11 |
| VI. Literature Reviewed | 16 |

# FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conduct of the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

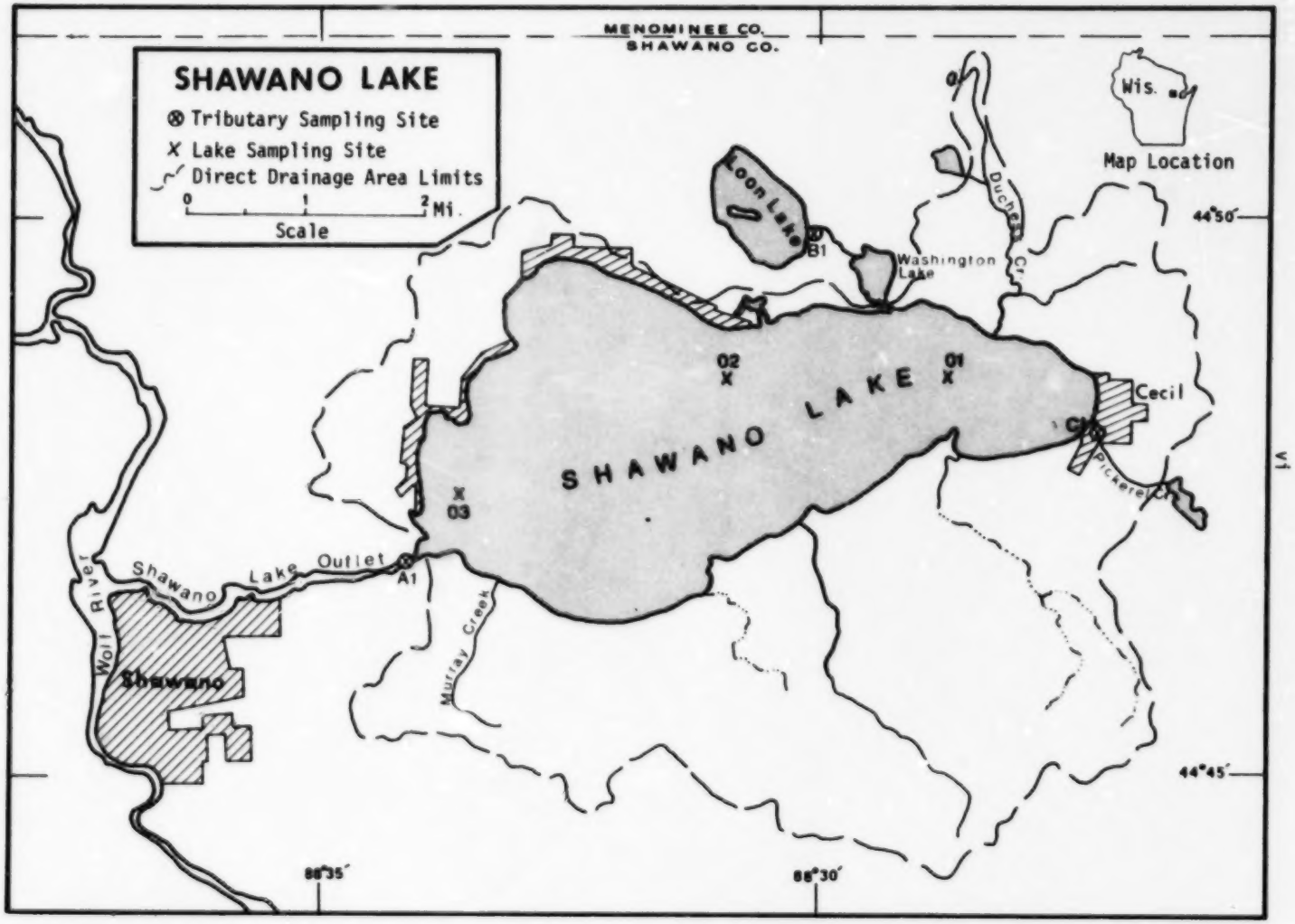
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

| LAKE NAME | COUNTY |
|---|---|
| Altoona | Eau Claire |
| Beaver Dam | Barron |
| Beaver Dam | Dodge |
| Big Eau Pleine | Marathon |
| Browns | Racine |
| Butte des Morts | Winnebago |
| Butternut | Price, Ashland |
| Castle Rock Flowage | Juneau |
| Como | Walworth |
| Crystal | Vilas |
| Delavan | Walworth |
| Eau Claire | Eau Claire |
| Elk | Price |
| Geneva | Walworth |
| Grand | Green Lake |
| Green | Green Lake |
| Kegonsa | Dane |
| Koshkonong | Jefferson, Rock, Dane |
| Lac La Belle | Waukesha |
| Long | Price |
| Middle | Walworth |
| Nagawicka | Waukesha |
| Oconomowoc | Waukesha |
| Okauchee | Waukesha |
| Petenwell Flowage | Juneau |
| Pewaukee | Waukesha |
| Pigeon | Waupaca |
| Pine | Waukesha |
| Poygan | Winnebago, Waushara |

| LAKE NAME | COUNTY |
|---|---|
| Rock | Jefferson |
| Rome Pond | Jefferson, Waukesha |
| Round | Waupaca |
| Shawano | Shawano |
| Sinnissippi | Dodge |
| Swan | Columbia |
| Tainter | Dunn |
| Tichigan | Racine |
| Townline | Oneida |
| Trout | Vilas |
| Wapogassett | Polk |
| Wausau | Marathon |
| Willow | Oneida |
| Winnebago | Winnebago, Fond Du Lac, Calumet |
| Wisconsin | Columbia |
| Wissota | Chippewa |
| Yellow | Burnett |


MENOMINEE CO.
SHAWANO CO.
SHAWANO LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
0 1 2 Mi.
Scale
Wis.
Map Location
Loon Lake
B1
Washington Lake
Duchess Cr.
44°50'
02
01
SHAWANO LAKE
Cecil
C1
Pickerel Cr.
03
Shawano Lake Outlet
A1
Wolf River
Shawano
Murray Creek
44°45'
88°35'
88°30'

# SHAWANO LAKE

## STORET NO. 5539

## I. CONCLUSIONS

### A. Trophic Condition:

Shawano Lake is eutrophic. Survey data indicate the trophic condition of this lake is more likely due to morphometry than to cultural influences.

### B. Rate-Limiting Nutrient:

Algal assay results and lake data indicate Shawano Lake was phosphorus limited during the sampling year.

### C. Nutrient Controllability:

1. Point sources--Except for septic tanks, there were no known point sources contributing nutrients to Shawano Lake during the sampling year. In fact, during that time, the lake received a total phosphorus load at a rate less than that proposed by Vollenweider (in press) as "permissible"; i.e., an oligotrophic rate (see page 15).

As for the septic tanks, the Shawano Lake Sanitary District is constructing a collection system (essentially completed as this report was written) and a treatment plant to serve lakeshore residences as well as provide treatment for the sewage from the City of Shawano. Phosphorus removal is included in the treatment, and the effluent will be discharged to the Wolf River downstream from the City of Shawano.

2. Non-point sources--The non-point nutrient exports of the sampled tributaries were somewhat low as compared to Wisconsin streams elsewhere (see page 15).

## II. INTRODUCTION

Shawano Lake is in the Wolf River drainage basin of northeastern Wisconsin (see map, page vi). Land use in the immediate drainage of the lake is primarily agricultural.

Recreational uses of the lake include swimming, boating, and fishing. Game fish present include muskellunge, northern pike, largemouth bass, and panfish. Although much of the shoreline is privately owned and extensively developed, particularly along the north and west shores, public access is provided and boats and services are available commercially.

The lake basin is relatively shallow, and the extensive littoral zone supports abundant growths of emergent and submergent aquatic plants.

## III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

### A. Lake Morphometry*:

1. Surface area: 6,156 acres.
2. Mean depth: 10.6 feet.
3. Maximum depth: 35 feet.
4. Volume: 65,044 acre/feet.
5. Mean hydraulic retention time: 1.5 years.

### B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

| Name | Drainage area† | Mean flow† |
|---|---|---|
| Loon Lake Outlet | 15.1 $mi^2$ | 13.4 cfs |
| Pickerel Creek | 17.4 $mi^2$ | 11.4 cfs |
| Minor tributaries & immediate drainage - | 32.8 $mi^2$ | 34.0 cfs |
| Totals | 65.3 $mi^2$ | 58.8 cfs |

2. Outlet -

| | | |
|---|---|---|
| Shawano Lake Outlet | 74.9 $mi^2$†† | 58.8 cfs†† |

### C. Precipitation†††:

1. Year of sampling: 37.1 inches.
2. Mean annual: 30.4 inches.

---

* DNR lake survey map (1941).
† Drainage areas are accurate within ±0.5%; mean daily flows are accurate within ±40%; mean monthly flows are accurate within ±35%; and normalized mean monthly flows are accurate within ±35%.
†† Includes area of lake; outlet flow adjusted to equal sum of inflows.
††† See Working Paper No. 1, "Survey Methods".

## IV. LAKE WATER QUALITY SUMMARY

Shawano Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 25 feet at station 1, 16 feet at station 2, and 4 feet at station 3.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

| | | FALL VALUES (11/08/72) | | |
|---|---|---|---|---|
| Parameter | Minimum | Mean | Median | Maximum |
| Temperature (Cent.) | 5.6 | 5.7 | 5.7 | 5.8 |
| Dissolved oxygen (mg/l | 10.5 | 11.1 | 11.1 | 11.7 |
| Conductivity (μmhos) | 230 | 233 | 235 | 240 |
| pH (units) | 7.7 | 7.7 | 7.7 | 7.8 |
| Alkalinity (mg/l) | 101 | 104 | 104 | 108 |
| Total P (mg/l) | 0.012 | 0.015 | 0.016 | 0.019 |
| Dissolved P (mg/l) | 0.006 | 0.008 | 0.008 | 0.009 |
| $NO_2$ + $NO_3$ (mg/l) | 0.040 | 0.042 | 0.040 | 0.050 |
| Ammonia (mg/l) | 0.050 | 0.056 | 0.050 | 0.070 |
| | | ALL VALUES | | |
| Secchi disc (inches) | 64 | 81 | 84 | 96 |

B. Biological characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | Number per ml |
|---|---|---|
| 06/22/72 | 1. Fragilaria | 2,242 |
| | 2. Flagellates | 506 |
| | 3. Dinobryon | 289 |
| | 4. Synedra | 271 |
| | 5. Melosira | 235 |
| | Other genera | 1,195 |
| | Total | 4,738 |
| 08/24/72 | 1. Polycystis | 673 |
| | 2. Anabaena | 304 |
| | 3. Fragilaria | 166 |
| | 4. Flagellates | 166 |
| | 5. Cryptomonas | 152 |
| | 6. Tabellaria | 145 |
| | Other genera | 782 |
| | Total | 2,388 |
| 11/08/72 | 1. Dinobryon | 1,229 |
| | 2. Microcystis | 788 |
| | 3. Asterionella | 239 |
| | 4. Fragilaria | 145 |
| | 5. Synedra | 108 |
| | Other genera | 528 |
| | Total | 3,037 |

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

| Sampling Date | Station Number | Chlorophyll a (µg/l) |
|---|---|---|
| 06/22/72 | 01 | 10.5 |
| | 02 | 35.7 |
| | 03 | 7.7 |
| 08/24/72 | 01 | 9.0 |
| | 02 | 7.7 |
| | 03 | 6.6 |
| 11/08/72 | 01 | 10.0 |
| | 02 | 9.7 |
| | 03 | 10.0 |

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

| Spike (mg/l) | Ortho P Conc. (mg/l) | Inorganic N Conc. (mg/l) | Maximum yield (mg/l-dry wt.) |
|---|---|---|---|
| Control | 0.008 | 0.093 | 0.7 |
| 0.006 P | 0.014 | 0.093 | 1.9 |
| 0.012 P | 0.020 | 0.093 | 2.1 |
| 0.024 P | 0.032 | 0.093 | 2.2 |
| 0.060 P | 0.068 | 0.093 | 2.0 |
| 0.060 P + 10.0 N | 0.068 | 10.093 | 29.4 |
| 10.0 N | 0.008 | 10.093 | 0.8 |

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Shawano Lake was relatively low at the time the sample was collected. Also, the increased yield resulting from the 0.006 mg/l orthophosphorus spike and the lack of response to

the addition of only nitrogen indicate the lake was phosphorus limited.

Note, however, that succeeding ortho-P spikes did not result in significantly increased yields until nitrogen was also added. This indicates that if orthophosphorus concentrations in the lake were increased to about 0.015 mg/l, the lake would become nitrogen limited.

The lake data indicate a phosphorus-limited condition during the other sampling periods as well. Nitrogen to phosphorus ratios were 17 to 1 in June and 16 to 1 in August; i.e., phosphorus limitation would be expected.

D. Trophic Condition:

The records of others indicate that Shawano Lake is eutrophic and that it probably would have been considered eutrophic even before cultural impacts began (Ketelle and Uttormark, 1971). The basin is relatively shallow, and the extensive littoral zones are conducive to the growth of aquatic plants.

Considering Survey data only, it could be concluded that the trophic condition of the lake was much better than the records of others indicate. Of the 46 Wisconsin lakes studied, 79% had greater mean total phosphorus, 90% had greater mean inorganic nitrogen, 81% had less Secchi disc transparency, and 77% had higher algal assay control yields.

As for nutrient loading rates, during the sampling year Shawano Lake was quite comparable to the oligotrophic lakes Sebago and Moosehead in Maine.

It is concluded, therefore, that the trophic condition of Shawano Lake is more likely due to morphometry than to cultural influences.

## V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Wisconsin National Guard collected a monthly near-surface grab sample from each or the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in September, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Wisconsin District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the means of the nutrient loads, in $lbs/mi^2/year$, at station B-1 and multiplying the means by the ZZ area in $mi^2$.

The Village of Cecil wastewater is treated in seepage ponds; and reportedly, there is no discharge to Shawano Lake (Schraufnagel, 1972).

---

* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal -

| Name | Pop. Served | Treatment | Mean Flow (mgd) | Receiving Water |
|---|---|---|---|---|
| Cecil | 369* | Seepage ponds | 0.036* | ? |

2. Industrial - None known.

* Estimated (1970 census; flow at 100 gallons/capita/day).

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

| Source | lbs P/ yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Loon Lake outlet | 540 | 13.5 |
| Pickerel Creek | 1,060 | 26.6 |
| b. Minor tributaries & immediate drainage (non-point load) - | 1,180 | 29.6 |
| c. Known municipal STP's - | | |
| Cecil | ? | - |
| d. Septic tanks* - | 250 | 6.2 |
| e. Industrial - | | |
| None known | - | - |
| f. Direct precipitation** - | 960 | 24.1 |
| Total | 3,990 | 100.0 |

2. Outputs -

Shawano Lake Outlet 3,060

3. Net annual P accumulation - 930 pounds.

* Estimated 400 dwellings on lakeshore; see Working Paper No. 1.
** Estimated; see Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

| Source | lbs N/yr | % of total |
|---|---|---|
| a. Tributaries (non-point load) - | | |
| Loon Lake outlet | 24,560 | 14.0 |
| Pickerel Creek | 29,200 | 16.6 |
| b. Minor tributaries & immediate drainage (non-point load) - | 53,330 | 30.3 |
| c. Known municipal STP's - | | |
| Cecil | ? | - |
| d. Septic tanks* - | 9,400 | 5.4 |
| e. Industrial - | | |
| None known | - | - |
| f. Direct precipitation** - | 59,310 | 33.7 |
| Total | 175,800 | 100.0 |

2. Outputs -

Shawano Lake Outlet 129,900

3. Net annual N accumulation - 45,900 pounds.

* Estimated 400 dwellings on lakeshore; see Working Paper No. 1.
** Estimated; see Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

| Tributary | lbs P/mi$^2$/yr | lbs N/mi$^2$/yr |
|---|---|---|
| Loon Lake outlet | 36 | 1,626 |
| Pickerel Creek | 61 | 1,678 |

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

| | Total Phosphorus | | Total Nitrogen | |
|---|---|---|---|---|
| Units | Total | Accumulated | Total | Accumulated |
| lbs/acre/yr | 0.6 | 0.2 | 29.0 | 7.5 |
| grams/m$^2$/yr | 0.07 | 0.02 | 3.2 | 0.8 |

Vollenweider loading rates for phosphorus (g/m$^2$/yr) based on mean depth and mean hydraulic retention time of Shawano Lake:

| | |
|---|---|
| "Dangerous" (eutrophic rate) | 0.28 |
| "Permissible" (oligotrophic rate) | 0.14 |

## VI. LITERATURE REVIEWED

Andrews, Lloyd M., and C. W. Threinen, 1968. Surface water resources of Shawano County. Dept. of Natural Resources, Madison.

Anonymous, 1972. Wisconsin lakes. Publ. 218-72, Dept. of Natural Resources, Madison.

Ketelle, Martha J., and Paul D. Uttormark, 1971. Problem lakes in the United States. EPA Water Poll. Contr. Res. Series, Project 16010 EHR.

Lueschow, Lloyd A., 1972. Biology and control of selected aquatic nuisances in recreational waters. Tech. Bull. #57, Dept. of Natural Resources, Madison.

McKersie, Jerome R., Robert M. Krill, James L. Lissack, and Ronald K. Krueger, 1971. Wolf River pollution investigation survey. Dept. of Natural Resources, Madison.

Schraufnagel, Francis H., 1972. Personal communication (Village of Cecil waste treatment facilities). Dept. of Natural Resources, Madison.

_____, 1974. Personal communication (status of Shawano Lake Sanitary District). Dept. of Natural Resources, Madison.

Vollenweider, Richard A., (in press). Input-output models. Schweiz A. Hydrol.

# VII. APPENDICES

## APPENDIX A

## TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5539 SHAWANO LAKE

TOTAL DRAINAGE AREA OF LAKE 74.90

| TRIBUTARY | SUB-DRAINAGE AREA | NORMALIZED FLOWS JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5539A1 | 74.90 | 23.93 | 31.94 | 68.75 | 149.48 | 88.74 | 85.53 | 48.88 | 32.85 | 43.81 | 46.85 | 52.84 | 30.93 | 58.67 |
| 553981 | 15.10 | 8.50 | 6.90 | 14.80 | 26.00 | 17.00 | 23.00 | 12.00 | 7.30 | 9.80 | 13.00 | 14.00 | 10.00 | 13.46 |
| 5539C1 | 17.40 | 4.00 | 7.90 | 19.00 | 33.00 | 15.00 | 15.00 | 7.80 | 5.90 | 7.50 | 7.60 | 10.00 | 4.40 | 11.40 |
| 5539ZZ | 42.40 | 13.00 | 18.00 | 39.00 | 86.00 | 50.00 | 56.00 | 28.00 | 19.00 | 25.00 | 27.00 | 30.00 | 18.00 | 34.05 |

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 74.90
SUM OF SUB-DRAINAGE AREAS = 74.90

TOTAL FLOW IN = 787.60
TOTAL FLOW OUT = 784.53

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 5539A1 | 9 | 72 | 56.00 | 24 | 43.00 | | | | |
| | 10 | 72 | 86.00 | 14 | 58.00 | | | | |
| | 11 | 72 | 75.00 | | | | | | |
| | 12 | 72 | 47.00 | 16 | 42.00 | | | | |
| | 1 | 73 | 31.00 | | | | | | |
| | 2 | 73 | 25.00 | 3 | 29.00 | | | | |
| | 3 | 73 | 640.00 | 3 | 23.00 | | | | |
| | 4 | 73 | 240.00 | 1 | 180.00 | 21 | 320.00 | | |
| | 5 | 73 | 310.00 | 6 | 300.00 | 26 | 270.00 | | |
| | 6 | 73 | 62.00 | 3 | 96.00 | | | | |
| | 7 | 73 | 11.00 | 28 | 11.00 | | | | |
| | 8 | 73 | 5.00 | | | | | | |
| 553981 | 9 | 72 | 12.00 | 24 | 8.00 | | | | |
| | 10 | 72 | 18.00 | 14 | 10.00 | | | | |
| | 11 | 72 | 15.00 | | | | | | |
| | 12 | 72 | 9.40 | 16 | 8.00 | | | | |
| | 1 | 73 | 3.70 | | | | | | |
| | 2 | 73 | 2.90 | 3 | 3.30 | | | | |
| | 3 | 73 | 300.00 | 3 | 2.70 | | | | |
| | 4 | 73 | 61.00 | 7 | 56.00 | 21 | 83.00 | | |
| | 5 | 73 | 79.00 | 6 | 76.00 | 21 | 46.00 | | |
| | 6 | 73 | 7.80 | 3 | 12.00 | | | | |
| | 7 | 73 | 0.70 | 28 | 0.70 | | | | |
| | 8 | 73 | 0.20 | | | | | | |

81

TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5539 SHAWANO LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

| TRIBUTARY | MONTH | YEAR | MEAN FLOW | DAY | FLOW | DAY | FLOW | DAY | FLOW |
|---|---|---|---|---|---|---|---|---|---|
| 5539C1 | 9 | 72 | 2.20 | 24 | 1.70 | | | | |
| | 10 | 72 | 3.50 | 14 | 2.00 | | | | |
| | 11 | 72 | 2.90 | | | | | | |
| | 12 | 72 | 2.20 | 16 | 1.90 | | | | |
| | 1 | 73 | 4.40 | | | | | | |
| | 2 | 73 | 3.50 | 3 | 4.00 | | | | |
| | 3 | 73 | 320.00 | 3 | 3.40 | | | | |
| | 4 | 73 | 69.00 | 7 | 62.00 | 21 | 93.00 | | |
| | 5 | 73 | 88.00 | 6 | 86.00 | 21 | 52.00 | | |
| | 6 | 73 | 9.20 | 3 | 14.00 | | | | |
| | 7 | 73 | 0.90 | 28 | 0.90 | | | | |
| | 8 | 73 | 0.20 | | | | | | |
| 5539ZZ | 9 | 72 | 33.00 | 24 | 25.00 | | | | |
| | 10 | 72 | 49.00 | 14 | 29.00 | | | | |
| | 11 | 72 | 43.00 | | | | | | |
| | 12 | 72 | 27.00 | 16 | 23.00 | | | | |
| | 1 | 73 | 15.00 | | | | | | |
| | 2 | 73 | 12.00 | 3 | 14.00 | | | | |
| | 3 | 73 | 490.00 | 3 | 11.00 | | | | |
| | 4 | 73 | 140.00 | 1 | 110.00 | 7 | 130.00 | 21 | 200.00 |
| | 5 | 73 | 190.00 | 6 | 180.00 | 21 | 110.00 | 26 | 170.00 |
| | 6 | 73 | 30.00 | 3 | 47.00 | | | | |
| | 7 | 73 | 4.20 | 28 | 4.20 | | | | |
| | 8 | 73 | 1.70 | | | | | | |

# APPENDIX B

## PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

553901
44 48 48.0 088 28 36.0
SHAWANO LAKE
55 WISCONSIN

11EPALES 2111202
3 0026 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/06/22 | 05 50 | 0000 | 19.2 | 6.8 | 96 | 200 | 8.20 | 103 | 0.050 | 0.110 | 0.025 | 0.012 |
| | 05 50 | 0015 | 19.3 | 6.3 | | 200 | 8.30 | 100 | 0.050 | 0.120 | 0.021 | 0.008 |
| | 05 50 | 0025 | 18.5 | 4.9 | | 205 | 7.70 | 101 | 0.050 | 0.190 | 0.020 | 0.006 |
| 72/08/24 | 11 00 | 0000 | | | 68 | 223 | 8.30 | 106 | 0.060 | 0.060 | 0.028 | 0.018 |
| | 11 00 | 0004 | 20.8 | 7.8 | | 223 | 8.30 | 104 | 0.060 | 0.060 | 0.032 | 0.008 |
| | 11 00 | 0015 | 20.5 | | | 223 | 8.35 | 102 | 0.060 | 0.070 | 0.021 | 0.008 |
| | 11 00 | 0020 | 20.4 | 6.6 | | 200 | 8.10 | 103 | 0.060 | 0.070 | 0.031 | 0.007 |
| 72/11/08 | 11 00 | 0000 | | | 72 | 240 | 7.70 | 107 | 0.040 | 0.060 | 0.012 | 0.006 |
| | 11 00 | 0004 | 5.8 | 11.4 | | 230 | 7.70 | 108 | 0.040 | 0.070 | 0.017 | 0.008 |
| | 11 00 | 0015 | 5.8 | 11.3 | | 230 | 7.70 | 107 | 0.040 | 0.060 | 0.016 | 0.009 |
| | 11 00 | 0024 | 5.8 | 11.7 | | 235 | 7.70 | 104 | 0.040 | 0.050 | 0.019 | 0.007 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/06/22 | 05 50 | 0000 | 10.5J |
| 72/08/24 | 11 00 | 0000 | 9.0J |
| 72/11/08 | 11 00 | 0000 | 10.0J |

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

553902
44 48 42.0 088 31 00.0
SHAWANO LAKE
55 WISCONSIN

11EPALES
3

2111202
0012 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/06/22 | 06 15 | 0000 | 18.9 | 7.2 | 84 | 205 | 8.20 | 101 | 0.050 | 0.100 | 0.025 | 0.012 |
| | 06 15 | 0010 | 18.9 | 9.0 | | 200 | 8.20 | 101 | 0.050 | 0.100 | 0.025 | 0.008 |
| 72/08/24 | 09 35 | 0000 | | | 64 | 223 | 8.25 | 102 | 0.070 | 0.090 | 0.024 | 0.009 |
| | 09 35 | 0004 | 20.3 | | | 222 | 8.25 | 110 | 0.070 | 0.070 | 0.022 | 0.009 |
| | 09 35 | 0010 | 20.3 | 7.2 | | 222 | 8.20 | 109 | 0.080 | 0.080 | 0.020 | 0.008 |
| | 09 35 | 0015 | 20.2 | 7.3 | | 225 | 8.25 | 109 | 0.070 | 0.070 | 0.018 | 0.007 |
| 72/11/08 | 10 40 | 0000 | | | 86 | 230 | 7.80 | 101 | 0.050 | 0.050 | 0.013 | 0.009 |
| | 10 40 | 0004 | 5.6 | 10.6 | | 230 | 7.80 | 103 | 0.040 | 0.050 | 0.017 | 0.009 |
| | 10 40 | 0016 | 5.6 | 11.0 | | 235 | 7.80 | 103 | 0.040 | 0.050 | 0.017 | 0.008 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/06/22 | 06 15 | 0000 | 35.7J |
| 72/08/24 | 09 35 | 0000 | 7.7J |
| 72/11/08 | 10 40 | 0000 | 9.7J |

J* VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

553903
44 47 48.0 088 33 30.0
SHAWANO LAKE
55 WISCONSIN

11EPALES
3

2111202
0006 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/06/22 | 06 30 | 0000 | 18.0 | 7.0 | 90 | 210 | 8.20 | 103 | 0.050 | 0.090 | 0.024 | 0.010 |
| | 06 30 | 0004 | 18.0 | 6.4 | | 210 | 8.10 | 104 | 0.050 | 0.080 | 0.026 | 0.013 |
| 72/08/24 | 09 20 | 0000 | | | | 220 | 8.35 | 109 | 0.070 | 0.070 | 0.020 | 0.008 |
| | 09 20 | 0004 | 19.6 | | | 220 | 8.40 | 108 | 0.060 | 0.060 | 0.021 | 0.008 |
| 72/11/08 | 10 25 | 0000 | | | 84 | 235 | 7.70 | 103 | 0.050 | 0.060 | 0.014 | 0.006 |
| | 10 25 | 0004 | 5.6 | 10.5 | | 235 | 7.70 | 104 | 0.040 | 0.050 | 0.014 | 0.007 |

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/06/22 | 06 30 | 0000 | 7.7J |
| 72/08/24 | 09 20 | 0000 | 6.6J |
| 72/11/08 | 10 25 | 0000 | 10.0J |

J* VALUE KNOWN TO BE IN ERROR

# APPENDIX C

# TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/02

5539A1 LS5539A1
44 47 30.0 088 34 00.0
SHAWANO LAKE OUTLET
55 15 SHAWANO
0/SHAWANO LAKE
CO HWY HHH BRDG 1 MI NE OF SHAWANO
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/24 | 14 40 | | 0.390 | 1.050 | 0.147 | 0.005K | 0.030 |
| 72/10/14 | 10 05 | | 0.084 | 0.600 | 0.115 | 0.005K | 0.021 |
| 72/11/11 | 14 30 | | 0.018 | 0.560 | 0.018 | 0.005K | 0.019 |
| 72/12/17 | 09 50 | | 0.028 | 0.600 | 0.046 | 0.005K | 0.016 |
| 73/01/06 | 11 40 | | 0.044 | 0.840 | 0.060 | 0.005K | 0.025 |
| 73/02/03 | 11 25 | | 0.050 | 2.200 | 0.126 | 0.005K | 0.015 |
| 73/03/03 | 11 35 | | 0.370 | 1.760 | 0.072 | 0.013 | 0.030 |
| 73/04/01 | 10 30 | | 0.015 | 0.920 | 0.048 | 0.007 | 0.040 |
| 73/04/21 | 14 30 | | 0.024 | 1.600 | 0.052 | 0.005K | 0.035 |
| 73/05/06 | 08 50 | | 0.016 | 0.720 | 0.035 | 0.012 | 0.025 |
| 73/05/26 | 14 00 | | 0.014 | 0.570 | 0.015 | 0.013 | 0.020 |
| 73/06/03 | 10 15 | | 0.018 | 0.705 | 0.022 | 0.005K | 0.020 |
| 73/07/28 | 09 40 | | 0.042 | 1.050 | 0.066 | 0.005K | 0.035 |
| 73/09/01 | 09 30 | | 0.010K | 0.640 | 0.018 | 0.008 | 0.040 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

553981 LS553981
44 50 00.0 088 30 00.0
LOON LAKE OUTLET
55 15 SHAWANO
T/SHAWANO LAKE
CO HWY E XING E SIDE OF LOON LAKE
11EPALES 2111204
4 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/24 | 14 25 | | 0.375 | 0.650 | 0.154 | 0.005K | 0.014 |
| 72/10/14 | 09 55 | | 0.061 | 1.250 | 0.102 | 0.005K | 0.020 |
| 72/11/11 | 14 45 | | 0.046 | 0.600 | 0.027 | 0.006 | 0.025 |
| 72/12/16 | 14 15 | | 0.069 | 0.680 | 0.076 | 0.007 | 0.022 |
| 73/01/06 | 11 25 | | 0.088 | 0.630 | 0.069 | 0.005K | 0.020 |
| 73/02/03 | 11 10 | | 0.140 | 0.850 | 0.120 | 0.005K | 0.015 |
| 73/03/03 | 11 20 | | 0.210 | 0.520 | 0.038 | 0.010 | 0.015 |
| 73/04/07 | 09 50 | | 0.100 | 0.560 | 0.017 | 0.005K | 0.015 |
| 73/04/21 | 14 20 | | 0.074 | 1.000 | 0.042 | 0.005K | 0.020 |
| 73/05/06 | 08 25 | | 0.230 | 1.000 | 0.032 | 0.015 | 0.035 |
| 73/05/21 | 13 50 | | 0.039 | 0.730 | 0.030 | 0.008 | 0.020 |
| 73/06/03 | 11 10 | | 0.042 | 0.730 | 0.030 | 0.005K | 0.020 |
| 73/07/28 | 10 15 | | 0.015 | 1.200 | 0.029 | 0.005K | 0.020 |
| 73/09/01 | 09 50 | | 0.010K | 0.520 | 0.032 | 0.006 | 0.020 |

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

5539C1 LS5539C1
44 48 30.0 088 27 07.0
PICKEREL CREEK
55 15 GILLETT
T/SHAWANO LAKE
ST HWY 117 BRDG IN CECIL
11EPALES 2111204
4 0000 FEET DEPTH



| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00630 NO2&NO3 N-TOTAL MG/L | 00625 TOT KJEL N MG/L | 00610 NH3-N TOTAL MG/L | 00671 PHOS-DIS ORTHO MG/L P | 00665 PHOS-TOT MG/L P |
|---|---|---|---|---|---|---|---|
| 72/09/24 | 14 10 | | 0.470 | 3.000 | 0.147 | 0.028 | 0.035 |
| 72/10/14 | 09 45 | | 0.096 | 1.200 | 0.130 | 0.009 | 0.031 |
| 72/11/11 | 15 15 | | 0.034 | 1.100 | 0.017 | 0.010 | 0.024 |
| 72/12/16 | 13 45 | | 0.040 | 1.400 | 0.102 | 0.028 | 0.093 |
| 73/01/06 | 11 10 | | 0.058 | 1.200 | 0.140 | 0.012 | 0.065 |
| 73/02/03 | 10 45 | | 0.087 | 1.100 | 0.096 | 0.012 | 0.060 |
| 73/03/03 | 11 00 | | 0.460 | 1.800 | 0.390 | 0.013 | 0.085 |
| 73/04/07 | 09 30 | | 0.022 | 1.380 | 0.027 | 0.005K | 0.025 |
| 73/04/21 | 14 00 | | 0.015 | 0.980 | 0.038 | 0.010 | 0.040 |
| 73/05/06 | 08 00 | | 0.069 | 1.000 | 0.046 | 0.011 | 0.025 |
| 73/05/21 | 13 30 | | 0.010K | 1.260 | 0.021 | 0.011 | 0.030 |
| 73/06/03 | 10 30 | | 0.011 | 0.950 | 0.021 | 0.015 | 0.040 |
| 73/07/28 | 10 00 | | 0.033 | 1.260 | 0.080 | 0.040 | 0.070 |
| 73/09/01 | 10 45 | | 0.014 | 0.920 | 0.037 | 0.040 | 0.075 |

K VALUE KNOWN TO BE LESS THAN INDICATED